CO_2 Laser Resurfacing of Psoriatic Plaques: A Pilot Study

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Background and Objective: **Laser resurfacing can precisely remove epidermis and papillary dermis, sites pivotal to the pathogenesis of psoriasis. Our objective was to determine the efficacy and safety of superficially ablating carbon dioxide (CO_2) lasers for treating isolated, recalcitrant psoriatic plaques.**
Materials and Methods: **Twelve adult subjects with stable, plaque-type psoriasis were recruited. In six volunteers, the quadrants received different numbers of passes with a 60 μsec pulsed CO_2 (*Tru-Pulse*) laser. In the remaining patients, one quadrant underwent curettage prior to resurfacing, the second resurfacing with a scanned continuous wave (*Sharplan Silktouch*) CO_2 laser and the last curettage alone.**
Results: **Despite clinical and histological evidence of complete ablation of the epidermis and papillary dermis, most quadrants recurred within 8 weeks. Surprisingly, two patients showed no recurrence after 4 months.**
Conclusion: **Ablation of the entire epidermis and papillary dermis with either pulsed or scanned CO_2 lasers appears generally ineffective in treating recalcitrant psoriatic plaques, although the clearing seen in two patients suggests potentially successful future research directions. Lasers Surg. Med. 22:165–170, 1998.**

Key words: **CO_2; resurfacing; psoriasis**

INTRODUCTION

Psoriasis is a common dermatologic disease characterized by hyperproliferation of the epidermis and affecting 1–2% of the world's population. The exact cause(s) remain unknown, although abnormal keratinocyte differentiation, polymorphonuclear leukocytes, neuropeptides, arachidonic metabolites, complement and immunologic mechanisms have all been reported to be involved. The earliest observable changes in psoriatic skin seen even prior to the development of a clinically apparent plaque are visible in the dermal papillary vasculature [1]. These events may be responsible for the initiation and perpetuation of typical plaques. There is apparently no reliable animal model for psoriasis. At present, psoriasis is treatable but not curable. Treatment options such as topical steroids, vitamin D derivatives, immunosuppressives, ultraviolet light therapy, and retinoids provide temporary benefit. Some plaques, however, remain recalcitrant to all forms of therapy. Such stubborn lesions are often on the elbows, knees, buttocks, and sacrum. These resistant areas are a source of continued frustration to both patient and physician.

Although lasers have not been traditionally employed for treating dermatoses, there is some precedent for considering their therapeutic use in psoriasis. First, the pulsed dye laser has been shown to induce prolonged remission in chronic plaque psoriasis [2,3]. Two early studies with the

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continuous wave (CW) carbon dioxide (CO_2) laser have shown promise [4,5]. The skin was precisely destroyed to a depth of 1 mm in three cases of circumscribed plaque psoriasis using a CO_2 laser with power density of 160–200 watts/cm^2 and a spot size of 2 mm. These reports challenge the widely accepted phenomenon of Koebnerization following trauma of psoriatic skin. One proposed hypothesis suggests that destruction of the superficial dermal microvasculature may remove a pivotal element in the pathogenesis of psoriasis. Another possible mechanism involves the destruction of fibroblasts in the upper dermis, which are known to induce hyperproliferation of normal keratinocytes [6]. Finally, severance of cutaneous nerve endings, a source of neuropeptides [7] that may provoke psoriasis, has been proposed to be the mechanism.

Given costs, risks of infection, and time constraints, it seems unlikely that anyone would seriously suggest treating large body surfaces with CO_2 lasers at this time. However, new CO_2 lasers for "resurfacing" skin might conceivably be used effectively and permanently to ablate isolated psoriatic plaques, especially those lesions in difficult to treat areas or those refractory to less aggressive modalities. The objective of this study was to determine the efficacy and safety of two superficially ablating carbon dioxide lasers for treatment of isolated, recalcitrant plaques. We examined the effect of the number of laser "passes," the anatomic depth of tissue ablation, and compared this laser technique to curettage.

MATERIALS AND METHODS

Informed consent was obtained from all volunteers who were recruited. Twelve nonpregnant, nonlactating adult volunteers with stable psoriasis having at least one plaque measuring a minimum of 20 cm^2 were recruited. Stable was defined as being present and unchanged for at least 3 months. Subjects were excluded if they had been on any systemic therapy such as oral steroids, methotrexate, cyclosporine, etretinate, hydroxyurea, and sulfasalazine within the past 8 weeks. Also excluded were those who had received UVB or PUVA phototherapy within the past 4 weeks or those who had used topical treatments such as steroids, calcipotriol, tar, and anthralin within the past 2 weeks. Those with a known history of keloids or hypertrophic scar formation were also excluded. Finally, patients on known photosensitizing medications were also excluded.

The test plaque was assessed according to erythema, thickness, and scaling. Each individual parameter was graded according to the same scale as follows: absent, slight, moderate, severe, and very severe. The volunteers were sequentially assigned to one of two groups, as described below.

Treatment Group A: Varying Depth of Pulsed CO_2 Laser Ablation

In this group, the selected test plaque was divided into equal quadrants. After sterile preparation, 1% lidocaine with epinephrine was infiltrated intradermally into the entire plaque. One quadrant was left untreated and served as a control. The remaining quadrants received increasing numbers of passes ranging from 2 to 22 with the pulsed Tru-Pulse CO_2 laser (Palomar Medical Technologies, Beverly, MA) at a pulse energy of 500 mJ and a spot size of 3 mm. This laser causes superficial ablation at this pulse energy. Debridement was performed after each pass using saline-soaked gauze. Because psoriatic plaques varied in thickness, resurfacing and debridement were initially performed until no more epidermis was clinically visible in the first quadrant undergoing treatment. In order to be certain a deep enough level of the papillary dermis had been reached, an additional 1-3 passes were performed on the next quadrant undergoing treatment. The final treatment quadrant received yet another 1–3 passes beyond those given in the intermediate quadrant.

Treatment Group B: Comparison of Pulsed CO_2 Laser With Other Destructive Modalities

In order to reduce the thickness of the psoriatic plaques more efficiently, superficial curettage with a 4 mm curet was performed until the plaque was at appreciably the same height as the surrounding epidermis. In addition, a scanned continuous wave (c.w.) CO_2 laser, (Sharplan Silktouch, Sharplan Lasers, Allendale, NJ) was employed on one of the quadrants. This scanned c.w. laser achieves higher energies and causes greater thermal damage, potentially reducing the need for curettage and multiple passes.

As in the first group, the test plaque was divided into quadrants, sterilely prepared and infiltrated with 1% lidocaine with epinephrine. The first quadrant served as a control. The second quadrant underwent curettage until no epidermis was visible, then laser resurfacing with the Tru-Pulse CO_2 laser using a pulse energy of 500 mJ with a spot size of 3 mm. The third quadrant was treated with the Sharplan Silktouch CO_2 laser us-

TABLE I. Treatment Group A. Varying Numbers of Tru-Pulse CO_2 Passes

Patient data	Skin type	Site	Scale	Erythema	Thickness	No. of passes	Results*
RH 43/M	II	L flank	Severe	Moderate	Moderate	2–4–6	2 wks—back to baseline
LB 43/F	II	R knee	Minimal	Moderate	Thin	2–4–6	2 wks—recurrence
IG 61/M	III	R thigh	Severe	Moderate	Severe	6–8–10	2 wks—thin plaques; 4 wks—back to baseline
CA 23/M	II	R leg	Moderate	Minimal	Thin	2–3–4	72 hours—signs of recurrence; 8 wks—back to baseline
PS 46/M	III	R leg	Severe	Moderate	Moderate	16–19–22	1 wk—macular; 2 wks—thin plaques; 8 wks—back to baseline
OG 36/M	IV	R leg	Severe	Moderate	Thin	14–17–20	8 wks—signs of recurrence; 12 wks—back to baseline

*Footnote: Regardless of the number of *Tru-Pulse CO_2* passes, there was no difference in response.

ing a laser power of 16 W, with 0.2 sec on/0.4 sec off exposure cycle and a scanned spot size of 6 mm per exposure cycle. This laser scanner employs a continuously spiraling mechanism that achieves somewhat the effect of a pulsed laser. Resurfacing was performed on the second and third quadrants until tissue contraction was seen. Debridement was performed after each pass with wet saline-soaked sponges. The fourth quadrant was treated with curettage alone.

Biopsies

Punch biopsies (4 mm) were performed on willing subjects before and immediately after laser resurfacing to facilitate ablation and coagulation necrosis depth assessment. The specimens were fixed in 10% buffered formalin and routinely stained with hematoxylin and eosin.

Postlaser Care and Evaluation

All subjects were asked to clean the areas with mild liquid soap and apply bacitracin ointment twice daily under a Telfa nonstick dressing for 1 week. Clinical evaluation and photography were performed within 1 week of treatment and again at 2, 4, and 8 weeks.

RESULTS

Treatment Group A

All six patients in group A completed the protocol. There were five men and one woman with a mean age of 42 years (range 23–61 years). Fitzpatrick [8] skin type distribution, the location of their test plaques, and the number of passes performed are listed in Table 1. There was no difference in response between quadrants that received varying numbers of passes. In five of the six patients, recurrence of the entire plaque was seen within 8 weeks of resurfacing. In the remaining patient, a reduction in thickness and scaling was noted at 4 weeks in all treated areas; however, the entire plaque returned to baseline by 12 weeks.

Treatment Group B

All six patients in group B also completed this protocol. There were five men and one woman with a mean age of 45 (range 18–61 years). The first four patients showed complete recurrence in all treated quadrants, starting as soon as 2 weeks after the treatment and returning to baseline status by 8 weeks (Table 2). The last two subjects, however, showed no recurrence in the second and third quadrants 4 months after laser resurfacing. These subjects received the greatest number of passes.

No adverse effects were noted in either subgroup. There were no wound infections. All subjects tolerated the treatments extremely well. Neither permanent pigmentary, nor textural effects, nor scarring were noted in any subject.

Biopsies

Thirteen specimens were obtained for standard hematoxylin and eosin sections. Control plaques showed the morphologic features typical of fully developed lesions of psoriasis, namely, regular psoriasiform epidermal hyperplasia, marked parakeratosis, subjacent attenuation or absence of granular cell layer, thinning of the suprapapillary epidermis, and an increased basilar mitotic index. Variable features included collections of neutrophils (Munro microabscess), dilated tortuous vessels with an edematous papillary der-

TABLE II. Treatment Group B. Curettage vs. Curettage Plus Tru-Pulse (T) vs. Sharplan Laser Resurfacing (S)

Patient data	Skin type	Site	Scale	Erythema	Thickness	No. of passes (T vs. S)	Results*
RH 43/M	II	R lower abdomen	Moderate	Minimal	Thin	6–4	2 wks—signs of recurrence; 8 wks—back to baseline
PS 46/M	III	L leg	Moderate	Moderate	Thin	10–7	8 wks—recurrence
IG 61/M	III	L knee	Severe	Moderate	Moderate	8–8	2 wks—signs of recurrence; 8 wks—back to baseline
PC 18/M	II	R leg	Moderate	Moderate	Thin	8–6	8 wks—back to baseline
SM 42/M	III	R knee	Severe	Moderate	Severe	14–12	no recurrence at 4 mos
JW 52/F	I	L leg	Moderate	Severe	Moderate	10–8	no recurrence at 4 mos

*Footnote: All plaques treated with curettage along recurred within 8 weeks.

mis, a superficial, predominantly mononuclear infiltrate, and papillary dermal concentric eosinophilic fibroplasia.

For group A, plaques immediately after treatment showed residual epidermis focally present; thickness ranged from 0.02–0.075 mm. For group B, plaques immediately after treatment showed typical alterations observed in acute, high energy thermal injury. No consistent difference was observed between the Tru-Pulse laser following curettage and the Sharplan Silktouch laser therapy alone. The epidermis was absent except for a few tufts of viable keratinocytes two to three layers thick. When present, the papillary dermis was capped by narrow zones of basophilic homogenized collagen fibers. In other areas, the papillary dermis was completely obliterated (Fig.1). Capillary endothelial injury consisted of coagulation necrosis of superficial endothelial cells. Several lumina contained necrotic cellular debris, coagulated red blood cells, and fibrin.

DISCUSSION

Psoriasis is a disease that continues to perplex physicians and torment patients around the world. Despite recent advances in therapy, all currently available treatment options do not attain permanent cure.

Lasers are a relatively new technology that have been tried for a wide range of dermatologic conditions including psoriasis. Indeed, different kinds of lasers have been used for treating localized psoriatic plaques, most notably the flashlamp pulsed dye laser [2,3], argon laser [9], and the CO_2 laser[4,5]. Pulsed dye lasers emit at a wavelength of 585 nm, visible radiation that selectively destroys cutaneous blood vessels up to a depth of at least 0.5 mm. Since the dermal papillary vasculature is believed to be responsible for the initiation and perpetuation of psoriasis, it was hoped that destruction of this plexus would result in clearing of psoriasis. Katagampola et al. [2] achieved moderate success with 5 out of 8 patients showing 50% improvement on the treated areas, but only after three fortnightly treatments with a fluence of 8.5 J/cm^2 (585 nm) and a spot diameter of 5 mm. Only one of their patients showed complete resolution.

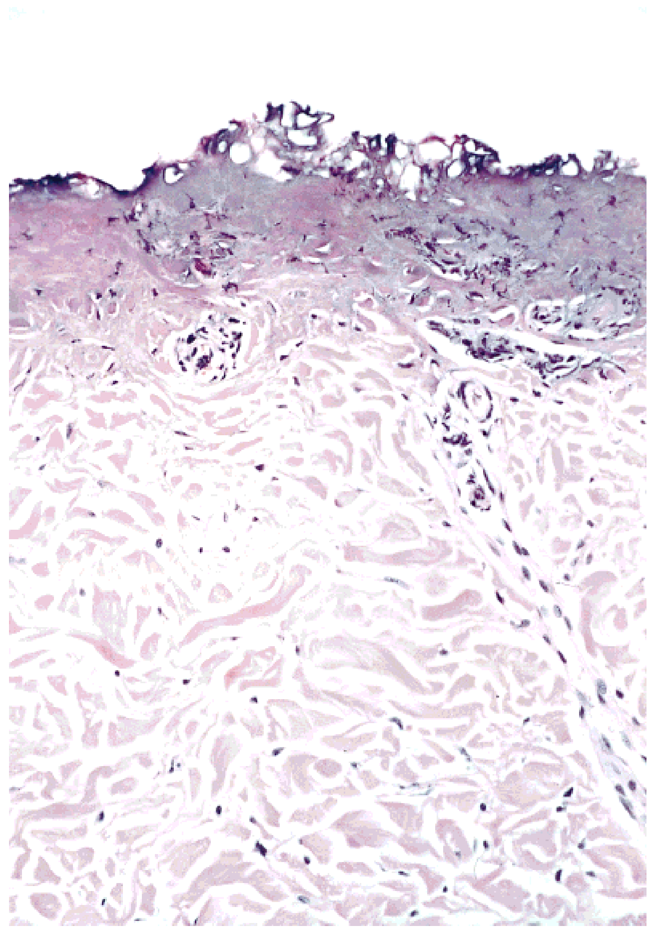

Fig. 1. High-power magnification H&E histology showing complete obliteration of the epidermis and papillary dermis immediately after laser treatment. Despite attaining such depth of ablation, recurrence of psoriatic plaque was noted.

Zelickson et al. [3] also used the pulsed dye laser and reported remissions of up to 13 months. Disadvantages of this modality are the need for multiple treatments and the high cost compared to effectiveness.

Harrison et al. [9] used an argon laser irradiating at 515 nm with a power of 250 mW, to photocoagulate plaques of psoriasis, in 19 patients. During the 12 months of their study, no recurrence of psoriasis was noted. Histologically, a significant reduction in epidermal thickness was observed, and superficial scar formation was seen clinically and histologically. It is not clear whether scarring is related to the potential for clearing of laser-treated psoriasis.

For over two decades, the traditional CO_2 laser has been used for tissue vaporization, coagulation, and cutting. It emits light at 10,600 nm, a far-infrared wavelength strongly absorbed by water. Unfortunately, there is a tendency to leave behind a very wide zone of coagulation necrosis, often resulting in unacceptable degrees of scarring. In 1985, success in treating three patients with circumscribed plaque psoriasis using a carbon dioxide laser in a continuous mode was reported [4]. The healed areas, although slightly depigmented, were as soft and elastic as normal skin. Histologically, aside from the slightly altered pigmentation, the skin in the treated area was normal in structure. These areas were reported to remain free of psoriasis for 3½ years. Morselli et al. [5] also successfully treated psoriatic plaques using a similar technique.

Psoriasis involves primarily the upper layers of the skin, namely, the epidermis and papillary dermis. These are the same layers removed by sequential, superficial laser "resurfacing" techniques used for treating rhytides and acne scars on the face [10,11]. Although CO_2 laser resurfacing causes mild fibrosis in the upper dermis, such changes may not be clinically apparent when the layer of fibrosis is thin. Because skin resurfacing lasers achieve more precise tissue ablation, they may conceivably provide an alternative treatment for isolated, recalcitrant plaques of psoriasis. Several different versions of CO_2 laser systems have been used to achieve precise tissue ablation for resurfacing. Automated scanning of a focussed, CW CO_2 laser also achieves superficial tissue vaporization. As used in this study, the Sharplan Silktouch CO_2 laser uses a rapidly scanning focused laser beam. With this device, the beam is scanned in a spiral pattern so that any given spot of tissue is irradiated for ~1 msec with an energy density of 5–15 J/cm^2 or more. Pulsed CO_2 lasers, such as the Tru-Pulse device used in this study, typically ablate a layer 50–150 μm deep per pass when used at 500 mJ energy over a 3 mm spot per pulse. An advantage of the Tru-Pulse laser is the short pulse duration of only 65 μsec, well below the thermal relaxation time (~700 μsec) of the layer directly heated by absorption of 10,600 nm photons. Scanned CW lasers tend to produce somewhat greater ablation and thermal injury per pass at equal fluences.

In order for laser resurfacing of psoriasis to be successful, destruction of the entire epidermis and papillary dermis, sites pivotal in the pathogenesis of psoriasis, would logically seem to be necessary. Because the thickness of individual psoriatic plaques varies markedly, the exact number of passes needed to achieve this effect would not be constant. As resurfacing proceeds deeper into the dermis, the tissue color of the surface changes. Entry into the papillary dermis appears as a pink color, whereas the deeper papillary dermis appears gray. When the upper reticular dermis is ablated, a yellowish base appears [12]. In this study, we tried to achieve complete epidermal and papillary dermis ablation by proceeding until the first appearance of yellow dermis. Visible tissue contraction occurs when the dermis is vaporized or heated [12]. This required far more passes of ablation than with normal skin. The elongated nature of the psoriatic epidermis and papillary dermis may simply make them more difficult to vaporize completely. Despite attaining complete destruction of the entire epidermis and papillary dermis in some of the study conditions, almost all of the psoriatic plaques recurred in all subjects. It seems that vaporization and/or surgical removal (curettage) of psoriatic epidermis and papillary dermis does not always remove the critical site(s) responsible for maintaining a plaque of psoriasis.

It is difficult to reconcile our results with previous reports of clearing of psoriasis after CO_2,[4,5] argon [9] and pulsed dye laser treatments [2,3]. In the case of CO_2 and argon lasers, scarring may be necessary to achieve clearing. Our study is one of the first to use pulsed or scanned "resurfacing" CO_2 lasers, which limit thermal damage and scarring. No scarring was observed, and no consistent therapeutic response either, despite very aggressive treatment of up to 22 passes of ablation. The remarkable propensity of psoriasis to heal (and to recur after healing) is apparent here. However, it is difficult to link scarring per se to therapeutic effect with lasers, in view of the

Katugampola [2] and Zelickson [3] studies. In these studies, a pulsed dye laser that selectively targets dermal microvasculature was effective without apparent scarring. One unifying explanation (among many possible) is that dermal vessels deeper than papillary dermis play a critical role in maintaining a plaque of psoriasis. Presumably, this would be the superficial and/or deep plexus that may have been damaged in the previously reported laser studies, but not in this study. Although some of our results appear promising, at present the CO_2 laser does not appear to be an acceptable treatment modality for psoriasis. Further studies are necessary to determine its effectiveness and define ideal treatment parameters.

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